



08/426591

EXTERIOR VEHICLE SECURITY LIGHTRELATED APPLICATIONS

This application is a continuation-in-part of pending application Serial No.

08/333,412 filed November 2, 1994, which is a continuation of application Serial No.

08/011,947 filed ^{Feb. 1, 1993} ~~December 16, 1992~~, now Patent No. 5,371,659.

BACKGROUND OF THE INVENTION

This invention relates generally to security systems for vehicles and, more particularly, to remotely actuated, personal safety lighting systems. The invention is particularly adapted to incorporation in the exterior mirrors of a vehicle.

Personal security in and around vehicles has become an important concern. In particular, an increasing number of assaults and robberies are committed in parking lots while occupants are entering and exiting vehicles. While remote-operated, keyless entry systems have been incorporated in vehicles in order to unlock the vehicle and illuminate interior lights, such systems merely expedite entry to the vehicle and do not, per se, enhance security around the vehicle. Accordingly, a need exists for a vehicle security system to increase the security for vehicle occupants while entering and exiting the vehicle. Any such system would need to be aesthetically pleasing and not burdensome in use.

In order to include a security light system in a vehicle exterior mirror assembly, the security light must be rugged and resistant to environmental conditions such as water splash from road surfaces, rain and other precipitation as well as car washes. The assembly desirably must additionally be of relatively low cost and easy to manufacture in order to be acceptable to vehicle manufacturers. In addition, the security light desirably

1 must be capable of matching a multiplicity of mirror housing designs. Moreover, the
security light desirably is compact so as to fit into the interior cavity of conventional exterior
mirror housings. For styling and aerodynamic reasons, exterior mirror housings are of
determined and restricted size, shape, design, and interior volume. Moreover, the interior
5 volume is already typically relatively cramped as it must accommodate not only the mirror
reflector element itself and its movement, but also usually a manual or electric actuator that
allows adjustment of the rearward field of view of the reflector remotely by the driver from
the interior cabin of the vehicle. Also, since it is commercially desirable for a manufacturer
of a security light to supply to a multitude of exterior mirror manufacturers, for their
10 incorporation into their own particular exterior mirror assembly construction, it is desirable
that the light be of a module type that is compact; that is weatherproofed; that is attachable
and receivable by a wide variety of exterior mirror assembly designs; that is readily,
standardly, and conveniently connectable to the vehicle electrical service and wiring already
commonly found in conventional exterior mirror assemblies; and that is economic both for
15 manufacture by the light module manufacturer and for the manufacturer of the complete
exterior mirror assembly who will incorporate the light module into a mirror housing.

Importantly, the security light must be easy to service. The vehicle repair
technician must be provided with easy access to the light source in order to replace the light
source during the useful life of the vehicle. Furthermore, the light source should be
20 replaceable without removing and subsequently replacing numerous fasteners. Such fasteners
are not only time-consuming to remove and replace, but are subject to getting lost as well as
damaged. Most or all of the above requirements must be met in order to have a

1 commercially viable vehicle exterior mirror assembly security system suitable for use on a
vehicle, such as an automobile. Indeed, the Applicants do not know of any successful
commercial incorporation of a light module into an exterior mirror assembly on an
automobile and believe that their inventions are the first commercially successful applications
5 of a light module suitable for use in the exterior mirror assembly on an automobile.

SUMMARY OF THE INVENTION

The present invention is intended to provide a personal safety feature for a
vehicle in the form of a light adapted to projecting light generally downwardly on an area
adjacent a portion of the vehicle in order to create a lighted security zone in the area.

10 Advantageously, the light, that preferably provides a security function, is provided as a
module that is suitable for use in the exterior mirror housing designs of various vehicles.

The light module is capable of low cost, easy manufacture. Furthermore, the module is
compact and is substantially moisture impervious in order to resist environmental forces.

Advantageously, the light module is easy to service in order to replace the light source by
15 requiring a minimum of, preferably one or no, fasteners in order to remove the module from
the exterior mirror assembly. Furthermore, the invention encompasses a signal light module
with the advantages described above and with the signal light generating a light pattern
discernable to drivers of overtaking vehicles but largely imperceptible to the driver of the
vehicle on which the signal light itself is mounted.

20 According to an aspect of the invention, a mirror assembly security system for
a vehicle includes an exterior mirror assembly having a reflective element and a housing for
the reflective element. A light module is removably positioned within the housing. The

1 light module projects light from the housing on an area adjacent a portion of the vehicle,
preferably in order to create a lighted security zone in that area. The light module includes
an enclosure, a light-transmitting opening in the enclosure facing downwardly or rearwardly
of the vehicle, or both, a cover for the light-transmitting opening, and a light source in the
5 enclosure. The light module may further include a serviceable, removable light source
receiving means, such as a socket positioned in another opening in the enclosure and a gasket
for sealing the socket in the opening, or with the mating surface of the socket to the opening
being self-gasketing. In this manner, the light source can be replaced by removing the light
module from the exterior mirror housing and removing the socket from the light module.
10 The light module and the mirror housing may have mating surface configurations, which at
least partially retain the light module in the housing. This may eliminate the requirement for
multiple fasteners which must be removed in order to service the light module.

The light module may further include a second light-transmitting opening in
the enclosure facing rearwardly of the vehicle, a second cover for the second light-
15 transmitting opening, and a second light source in the second enclosure radiating light
through the second light-transmitting opening. This feature may provide a signal light for
use as either a turn signal, a brake signal, or both, visible from the side of the equipped
vehicle. In a preferred embodiment, the second light source is a plurality of light-emitting
diodes and includes louvers between the light-emitting diodes. The louvers may be skewed
20 in a direction away from the vehicle passenger compartment in order to shield the driver
from light radiated by the light-emitting diodes.

1 The light module is preferably substantially moisture impervious in order to be
resistant to environmental elements. The enclosure is preferably a unitary assembly with the
lens covering the light-transmitting opening permanently joined with the remainder of the
enclosure. The light source is preferably serviceably, movably received within the enclosure
5 by a socket that engages in an opening in the enclosure. In this manner, the light source
may be replaced by removing the light module from the exterior mirror housing, removing
the socket from the enclosure and replacing the light source in the socket.

 The invention provides a universal configuration for a mirror assembly
security system, which allows the vehicle manufacturer to offer a mirror assembly system
10 having only the security light feature, which projects light from the housing on an area
adjacent a portion of the vehicle in order, for example, to create a lighted security zone in
that area. Alternatively, the invention allows the vehicle manufacturer to offer a mirror
assembly having an additional or a stand-alone signal light; for example, a turn signal, a
brake light, or both a turn signal and a brake light. The signal light increases security for
15 the vehicle occupant by providing signals to vehicles overtaking the equipped vehicle from
the side. The signal light may be designed to be observed by other vehicles passing the
equipped vehicle, but not directly by the driver of the equipped vehicle.

 The security system is adapted to projecting a pattern of light from the exterior
mirror housing on an area adjacent a portion of the vehicle that extends laterally onto the
20 vehicle and downwardly and rearwardly of the vehicle. In this manner, a security zone is
established in the vicinity of the vehicle doors where occupants enter and exit the vehicle.
The signal light is adapted to projecting a pattern of light extending laterally away from the

1 vehicle and rearwardly of the equipped vehicle. In this manner, the pattern generated by the
signal light cannot be substantially observed by a driver of the equipped vehicle. However,
the pattern generated by the signal light may be observed by a driver of another vehicle
passing the vehicle equipped according to the invention.

5 By providing a lighted security zone adjacent the vehicle, users can observe
suspicious activity around the vehicle. The pattern of light generated by a security light
according to the invention establishes a security zone around, and even under, the vehicle in
the important area where the users enter and exit the vehicle. The invention, further,
conveniently combines a signal light that acts in unison with the vehicle's turn signal, brake
10 light, or both, with the security light, or as a stand-alone accessory, in an exterior mirror
assembly. The signal light may be designed to be observed by other vehicles passing the
equipped vehicle but not directly by the driver of the equipped vehicle.

These and other objects, advantages and features of this invention will become
apparent upon review of the following specification in conjunction with the drawings.

15 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view taken from the front of a mirror assembly (rear of
the vehicle) incorporating the invention;

Fig. 2 is a rear view of the mirror assembly in Fig. 1;

Fig. 3 is a top view of the mirror assembly in Fig. 1;

20 Fig. 4 is the same view as Fig. 1 of an alternative embodiment of the
invention;

Fig. 5 is a block diagram of a control system according to the invention;

1 Fig. 6 is a block diagram of an alternative embodiment of a control system according to the invention;

 Fig. 7 is a breakaway perspective view of the system in Fig. 1 revealing internal components thereof;

5 Fig. 8 is a sectional view taken along the lines VIII-VIII in Fig. 7;

 Fig. 9 is a sectional view taken along the lines IX-IX in Fig. 7;

 Fig. 10 is a side elevation of a vehicle illustrating the security zone light pattern generated by a security light according to the invention;

 Fig. 11 is a top plan view of the vehicle and light pattern in Fig. 10;

10 Fig. 12 is a rear elevation of the vehicle and light pattern in Fig. 10;

 Fig. 13 is a side elevation of a vehicle illustrating the light pattern generated by a signal light useful with the invention;

 Fig. 14 is a top plan view of the vehicle and light pattern in Fig. 13;

 Fig. 15 is a rear elevation of the vehicle and light pattern in Fig. 13;

15 Fig. 16 is the same view as Fig. 7 of a first alternative light source according to the invention;

 Fig. 17 is the same view as Fig. 7 of a second alternative light source;

 Fig. 18 is the same view as Fig. 7 of a third alternative light source;

 Fig. 19 is the same view as Fig. 7 of a fourth alternative light source;

20 Fig. 20 is the same view as Fig. 7 of the invention embodied in an alternative mirror structure;

1 Fig. 21 is an exploded perspective view taken from the front of a mirror
assembly (rear of the vehicle), according to another aspect of the invention;

Fig. 22 is an exploded perspective view illustrating details of the light module;

Fig. 23 is a sectional view taken along the lines XXIII-XXIII in Fig. 22;

5 Fig. 24 is a front elevation of the mirror assembly in Figs. 21 and 22
illustrating the manner in which a light module is removably mounted to an exterior rearview
mirror housing;

Fig. 25 is the same view as Fig. 23 of an alternative embodiment;

10 Fig. 26 is an exploded perspective view taken from the front of a mirror
assembly of another alternative embodiment of the invention;

Fig. 27 is a sectional view taken along the lines XXVII-XXVII in Fig. 26;

Fig. 28 is a sectional view taken along the lines XXVIII-XXVIII in Fig. 26;

Fig. 29 is the same perspective view as Fig. 22 of another alternative
embodiment;

15 Fig. 30 is a front elevation of the mirror assembly in Fig. 29 illustrating the
light module mounted to the support bracket; and

Fig. 31 is a sectional view taken along the lines XXXIII-XXXIII in Fig. 30.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now specifically to the drawings, and the illustrative embodiments
20 depicted therein, a vehicle personal security lighting system 25 includes an exterior mirror
assembly 26 having a conventional reflectance element 28, a security light 30, preferably
white, or clear, and a signal light 32, preferably red or red-orange, incorporated in a

1 housing, or casing, 34. Casing 34 is connected by a neck 36 to a stationary panel or sail 38
adapted for incorporation with the forward portion of the vehicle side window assembly, and
which mounts mirror assembly 26 to the door of a vehicle 40 (see Fig. 10). Reflectance
element 28 may be any of several reflectors, such as glass coated on its first or second
5 surface with a suitable reflective layer or layers, such as those disclosed in United States
Patent No. 5,179,471, the disclosure of which is hereby incorporated by reference herein, or
an electro-optic cell including a liquid crystal, electrochromic, or electrochemichromic fluid,
gel or solid-state compound for varying the reflectivity of the mirror in response to electrical
voltage applied thereacross as disclosed in United States Patent No. 5,151,824, the disclosure
10 of which is hereby incorporated by reference herein.

With reference to Figs. 7 and 8, as is conventional, reflectance element 28 is
mounted to a bracket 43 by a positioning device such as an actuator 42. Casing 34 is
mounted to bracket 43. Actuator 42 provides remote positioning of reflectance element 28
on two orthogonal axes. Such actuators are well known in the art and may include a
15 jackscrew-type actuator 42 such as Model No. H16-49-8001 (right-hand mirror) and Model
No. H16-49-8051 (left-hand mirror) by Matsuyama of Kawagoe City, Japan, as illustrated in
Fig. 7, or a planetary-gear actuator 42' such as Model No. 540 (U.S. Patent No. 4,281,899)
✓ sold by Industrie Koot BV (IKU) of Montfoort, Netherlands, as illustrated in Fig. 20. As is
also conventional, the entire casing 34 including actuator 42, 42' is mounted via bracket 43
20 for breakaway motion with respect to stationary panel 38 by a breakaway joint assembly 44.
Breakaway joint assembly 44 (Fig. 9) includes a stationary member 46 attached to vehicle
40, a pivoting member 48 to which bracket 43 and casing 34 are attached, and a wire-way 50

1 through which a wire cable 52 passes. Wire cable 52 includes individual wires to supply
control signals to actuator 42, 42', as well as signals to control the level of reflectivity, if
reflective element 28 is of the variable reflectivity type noted above, such as an
electrochromic mirror. Power may also be supplied through cable 52 for a heater 53 as
5 disclosed in United States Patent No. 5,151,824 in order to evaporate ice and dew from
reflective element 28.

With reference to Fig. 5, actuator 42, 42' receives a first set of reversible
voltage signals from a switch 54, in order to bidirectionally pivot in one axis, and a second
set of reversible signals from a switch 56, in order to bidirectionally pivot in the opposite
10 axis, as is conventional. Switches 54 and 56 are actuated by a common actuator (not shown)
that is linked so that only one of the switches 54 and 56 may be actuated at a time. In this
manner, actuator 42, 42' may utilize one common conductor for both switches 54, 56.

Each of the security light 30 and signal light 32 includes a light source 60 and
reflector 62 behind a lens 64 (Fig. 8). Light source 60, reflector 62 and lens 64 are
15 designed for security light 30 to project a pattern 66 of light, such as white light, through a
clear, non-filtering lens, in order to establish a security zone around the vehicle (Figs. 10-
12). Pattern 66 extends rearward from mirror assembly 26. Vertically, pattern 66 contacts
the ground at 68 in the vicinity of entry and exit by the vehicle occupants (Figs. 10 and 12).
Laterally, pattern 66 fans out into contact with the side 70a, 70b of the vehicle. This contact
20 washes the sides of the vehicle to reflect the light in order to further illuminate the area in
order to establish the security lighting zone (Figs. 11 and 12). In a preferred embodiment,

1 pattern 66 extends rearwardly from mirror assembly 26 without projecting any portion of the pattern forwardly of the mirror assembly.

Signal light 32 generates a light pattern 72, which is directed generally horizontally rearwardly of vehicle 40 (Figs. 13-15). Pattern 72 is laterally directed substantially away from side 70a, 70b of vehicle 40 so that the driver of vehicle 40 does not directly intercept pattern 72, although a minor intensity (such as 10%) of the pattern is intercepted by the driver in order to provide awareness of the actuating of the signal light. Pattern 72 fans laterally away from side 70a, 70b to an extent that is parallel the face of reflectance element 28, which is substantially perpendicular to side 70a, 70b (Fig. 14).

10 Thus, the driver of another vehicle (not shown) passing vehicle 40 on the left or right side of vehicle 40 will intercept pattern 72 while the vehicle is behind and beside vehicle 40.

Although, in the illustrated embodiment, lens 64 of signal light 32 is substantially planar, lens 64 of signal light 32 could be made to wrap around the outward side of casing 34 in order to function as a side marker for the vehicle as is required in some European countries.

15 Vehicle mirror assembly security system 25 is actuated by a control system 74 (Fig. 5). Control system 74 includes means for actuating security light 30 including a remote transmitting device 76 and a stationary receiving device 78. Transmitting device 76 may be remotely carried by the vehicle operator and includes switches 80 and 81 in order to actuate the transmitting circuitry to transmit a signal from antenna 82, which is received by antenna 84 of receiving device 78. Receiving device 78 is mounted in the vehicle, such as in the vehicle trunk compartment, interior cabin, or within or on a mirror assembly, and includes an output 86 in order to operate remote door lock circuit 88, as is conventional.

1 For example, an antenna, such as a metallic antenna comprising, for example, 6 to 20 gauge
copper wire, and/or an RF, IR, and the like signal receiving circuit, may be incorporated
into one, and preferably both, of the exterior mirror assemblies, or into the interior mirror
assembly, or into vehicle glazing, trim items such as sunvisors and overhead consoles, and
5 their like. Such an antenna can be auxiliary mounted, integrally mounted, or insert molded
into or onto, for example, the exterior mirror bracket, sail, housing, bezel, or visor, or could
be part of the light module. Such receiving system can be of the automatic, proximity
✓ detection type that automatically senses proximity and approach of the vehicle owner by its
automatic detection of the transducer carried by the vehicle owner, without that vehicle
10 owner having necessarily to operate neither a button on a hand-held unit. Also, the receiver
may be part of, or itself be, a proximity detection system that activates and illuminates the
light module of this invention whenever the vehicle is approached under conditions where
vehicle security is being detected and protected.

Output 86 is, additionally, provided as an input 90 of a lockout circuit 92,
15 whose output 94 is supplied to security lamp 30. Input 90 may additionally be actuated by a
timeout circuit 96, which is conventionally supplied in a vehicle in order to dim the interior
lights, following a slight delay, after the occurrence of an event, such as the opening and
closing of the doors of the vehicle. Signal light 32 is actuated on line 98 from either a turn
indicator circuit 100 or a stop lamp indicator circuit 102, both of which are conventionally
20 supplied with vehicle 40.

In operation, when the operator actuates switch 80 of transmitting device 76,
receiving device 78 produces a signal on output 86 in order to cause remote door lock circuit

1 88 to unlock the doors. Alternatively, actuation of switch 81 on remote transmitting device
76 causes receiving device 78 to produce a signal on output 86 to cause remote door lock
circuit 88 to lock the vehicle doors. The signal on output 86 actuates security lamp 30
provided that lockout circuit 92 does not inhibit the signal. Lockout circuit 92 responds to
5 operation of the vehicle in order to avoid actuation of security lamp 30 when the vehicle is in
motion. Such lockout circuits are conventional and may be responsive to placing of the
vehicle transmission in gear or sensing of the speed of the vehicle, or the like. The lockout
circuit may also be included in the vehicle's ignition system, such that the security light is
disabled when the engine is started and the vehicle is operating. Thus, the lamp will be off
10 when the ignition switch is turned to start the engine. Security lamp 30 is also actuated, in
response to interior lighting device timeout circuit 96, whenever the interior lights of the
vehicle are being actuated by timeout circuit 96, provided that lockout circuit 92 does not
inhibit the signal from security lamp 30. This is provided in order to allow security lamp 30
to be actuated in response to the entry to, or exit from, vehicle 40 without the operator
15 utilizing transmitting device 76 to lock or unlock the doors. Signal lamp 32 is actuated in
response to turn indicator circuit 100 whenever the operator moves the indicator stick in the
direction of that particular signal lamp 32. Signal lamp 32 may additionally be actuated from
stop lamp circuit 102 in response to the driver actuating the vehicle's brakes.

In the embodiment illustrated in Figs. 1 and 5, lens 64 of signal lamp 32 is
20 adapted to filter the light provided from lamp 32 so as to be red and is provided for vehicles
40 in which the stop lamps and rear turn indicator lamps are, likewise, red. Because signal
lamp 32 shines red, pattern 72 is restricted from extending forward of the vehicle. This is in

1 order to comply with regulations prohibiting red lights from causing confusion with
emergency vehicles by shining forward of the vehicle.

For vehicles having red stoplights and amber turn indicators in the rear, a
vehicle mirror security assembly 25' includes an exterior mirror assembly 26' and a control
5 system 74' (Figs. 4 and 6). Exterior mirror assembly 26' includes a security light 30',
preferably white or clear, and a pair of signal lights 32a' and 32b'. Signal light 32a' is
amber and is actuated directly from turn indicator circuit 100'. This amber color can be
provided either by an amber light bulb or source, or a filtering lens providing an amber
color. Signal light 32b' is red, red-orange or amber, as desired by the automaker, and is
10 actuated directly from stop lamp circuit 102'. Each of the light patterns generated by signal
lights 32a' and 32b' substantially correspond with light pattern 72. The light pattern
generated by security light 30' is substantially equivalent to pattern 66. With the exception
that turn signal indicator circuit 100' actuates signal light 32a' and stop lamp circuit 102'
actuates signal light 32b', control system 74' operates substantially identically with control
15 circuit 74.

In the illustrated embodiment, light source 60, for both security light 30 and
signal light 32, may be supplied as a conventional incandescent or halogen lamp 60a (Fig. 7).
Alternatively, a conventional incandescent fuse lamp 60b may be used (Fig. 16).
Alternatively, a vacuum fluorescent lamp 60c, which is available in various colors, may be
20 used (Fig. 17). Alternatively, a light-emitting diode 60d may be used (Fig. 18). As yet a
further alternative, a fiber optic bundle 104 forming a light pipe may be positioned to
discharge light behind lens 64. Fiber optic bundle 104 passes through breakaway joint 44 in

1 wire-way 50 in order to transmit light from a source (not shown) within vehicle 40. By way
of example, lens 64 may be supplied as a clear lens, a diffuser lens, a segmented lens, a
prismatic lens, or a Fresnel lens in order to generate light patterns 66 and 72. Bracket 43
and breakaway joint 44 are marketed by Donnelly Corporation, the present assignee, of
5 Holland, Michigan. The remote actuator composed of remote transmitting device 76 and
stationary receiving device 78 may be radio frequency coupled, as is conventional.
Alternatively, they may be infrared coupled as illustrated in United States Patent No.
4,258,352.

Although the invention is illustrated in a mirror assembly utilizing an
10 automatic remote actuator, it may also be applied to manual remote actuators and handset
actuators. As previously set forth, reflectance element 28 may be conventional or may be
supplied as an electrochromic self-dimming mirror. Although the invention is illustrated with
breakaway joint 44, the invention may also be applied to mirrors that are rigidly mounted to
the vehicle.

15 An alternative vehicle personal security lighting system 25' includes a light
module 104 that is removably positioned within housing 34' of exterior mirror assembly 26'
(Fig. 21). In addition to the opening for accepting bezel or cowling 106, mirror housing 34'
includes a downward opening 108 for receiving light module 104. Additionally, bezel 106
includes a recess 110 which defines an opening facing generally downwardly and rearwardly
20 of the vehicle. Exterior mirror assembly 26 includes a bracket 43' for mounting positioning
device 42 which mounts reflective element 28. Bracket 43' has two pairs of flexible prongs
112, which are received within sockets 114 defined on an enclosure 116 of light module 104.

1 Prongs 112 releasably engage sockets 114 in order to retain the light module within the
exterior mirror assembly in openings 108 and 110. Light module 104 may be disassembled
from exterior mirror assembly 26' by reaching behind reflective element 28 with a pair of
needle-nose pliers, or the like, and sequentially compressing each of the pairs of prongs 112
5 in order to release the prongs from sockets 114. Thus, prongs 112 and sockets 114 provide
a fastener-less system which retains the light module in the exterior mirror assembly without
the use of separate fasteners. A pair of shoulders 118, which define a slot 120 therebetween,
engage a protrusion from an inner surface (not shown) of housing 34' in order to assist in
stably positioning light module 104 within housing 34'. Alternatively, one or more
10 fasteners, such as screws, clasps, latches, clips, and their like could be used. But,
preferably, for ease of serviceability and for consumer acceptability, only one, and at most
two, such fastener should be used. A further advantage of a fastener-less system is that it
facilitates supply of a light module of this invention for use in a plurality of exterior mirror
assemblies manufactured by a multitude of exterior mirror manufacturers with minimum
15 modifications to the complete mirror assembly housing.

Unitary enclosure 116 has a generally downwardly directed light-transmitting
opening 122 and an opening 121 for receiving a light socket 124. Light socket 124 provides
electrical connection to a light source 126, which is electrically interconnected to the vehicle
through a cable 128. The socket may be self-gasketing, achieved by selection of a material
20 in its construction, at least at the mating surface, that achieves a sealing function.

Preferably, the socket, either wholly, or partially at least at its mating surface, is a resilient,
somewhat flexible polymer material, preferably with a durometer hardness, measured on the

1 SHORE A scale of less than approximately 95, more preferably less than approximately 85,
and most preferably less than approximately 75 but preferably of SHORE A hardness greater
than about 50, and preferably greater than about 60. Materials appropriate to achieve this,
and simultaneously have the physical, mechanical, and high temperature performance needed,
5 include silicone, urethanes, thermoplastic rubbers, and polyvinyl chloride. Preferably, the
material used for the self-gasketing socket is capable of withstanding temperatures in use in
excess of approximately 200° F or higher. Alternatively, a rigid construction may be used
for the light socket, such as a ceramic, engineering plastic, Bakelite, nylon, polyester, filled
polyester, or filled (glass and/or mineral) nylon, if a gasketing material delivering the above
10 properties are used at the point of mating of light socket 124 and enclosure 116. Light
socket 124 seals against enclosure 116 by the provision of a gasket, which, in the illustrated
embodiment, is provided by the flexible nature of light socket 124. Alternatively, a separate
gasket member formed of material such as silicone, neoprene, thermoplastic rubber, EPDM,
polypropylene/EPDM alloy and similar elastomeric materials, preferably having the hardness
15 properties listed above, could be inserted between the light socket and the enclosure. Light-
transmitting opening 122 is covered by a cover member 130. Cover member 130 is a lens
member, which affects the distribution of light emitted from light source 126. In the
illustrated embodiment, cover member 130 is a clear optic lens that provides a substantially
uniform puddle of light on the illuminated area adjacent the vehicle's door having a relatively
20 wide light pattern, or flood pattern. Alternatively, cover member 130 could be a diffractive
optic, a diffusive optic, a refractive optic, a reflective optic, a holographic optic, a binary
optic, or a sinusoidal optic. In the illustrated embodiment, light source 126 is an

1 incandescent lamp that is a filament optic having a minimum five-candle power. Such candle
power mounted within an exterior mirror assembly of an automobile will preferably produce
a ground surface illumination intensity of at least approximately 5 lux or greater, more
preferably at least about 10 lux, and most preferably at least about 20 lux. Light source 126
5 may range in power up to 32-candle power or more. The preferred range is between
approximately 5-candle power and approximately 15-candle power. It is desirable to provide
as much candle power as possible without creating excessive heat within enclosure 116. If a
high wattage lamp is used, a ventilation system is provided. Ventilation techniques are
known in the art which allow the passage of air through the cavity 134 in which the light
10 source is positioned while providing a substantially moisture-impervious barrier.

Light module 104 additionally includes a reflector 132 surrounding light source
126, both positioned in a cavity 134, which extends to light-transmitting opening 122. The
purpose of the reflector is in order to direct the light from light source 126 into the pattern of
light illustrated in Figs. 10-12. Reflector 132 may be a parabolic reflector, as illustrated in
15 Fig. 23, but may additionally include an extended tunnel in order to provide collimation of
the light beam. In the illustrated embodiment, reflector 132 is aluminum or high efficiency
aluminum vacuum-deposited on a wall 133 defining cavity 134, with an optional coating of
lacquer. Alternatively, wall 133 may be coated with a white paint, such as "Argent" white
or a silver paint. Reflector 132 may be a separate member, such as stamped metal or an
20 aluminized glass optic. Alternatively, light source 126 and reflector 132 may be provided as
an assembly.

1 Light module 104 includes a second cavity 140 defined in enclosure 116 and
extending to a second light-transmitting opening 136. A signal light assembly 138 is
positioned within cavity 140 to radiate light rearwardly with respect to the vehicle. Signal
light assembly 138 includes a pair of electrical contacts 142, which protrude through grooves
5 144 defined in a flange 146 surrounding opening 136. Contacts 142 engage a connector 148,
which provides electrical connection between signal light assembly 138 and the vehicle
through cable 128 which, in turn, may piggyback or otherwise connect to existing 12-volt
battery/ignition wiring already supplied in the housing to service an electrical actuator and/or
a defroster heater pad.

10 Signal light assembly 138 includes a plurality of light-emitting diodes 152
positioned on circuit board 150. A variety of emitting sources may be used as light-emitting
source 90, including, but not limited to, very high intensity amber and reddish-orange light-
emitting diode (LED) sources, such as solid-state light-emitting diode (LED) sources utilizing
double heterojunction AlGaAs/GaAs material technology, such as very high intensity red
15 LED lamps T-1 3/4 (5 mm) HLMP-4100/4101, available from Hewlett Packard Corporation,
Palo Alto, California, or which use transparent substrate aluminum indium gallium phosphide
(AlInGaP) material technology, commercially available from Hewlett Packard Corporation,
Palo Alto, California under the designation T-1 3/4 (5mm) HLMT-DL00, HLMT-CH00,
HLMT-CL00, HLMT-CH15, HLMT-CL15 and HLMT-DH00 or high power AlInGaP amber
20 and reddish-orange lamps under the designation HLMA-CH00/-CLOO, HLMA-DGOO/-
DH00/-DLOO, HLMA-EH2O/-EL2O, HLMA-KH00/-KL00, and HLMA-QH00/-QLOO,
or which use InGaAlP material technology available from Toshiba Corporation of Latham,

1 New York, such as under the designation TLRH180D or GaAlAs/GaAlAs LED sources
available from Sharp Corporation Electronics Components Group such as Model No.
GL6UR31T and Model No. GL6UR3T which are red LEDs. Light emittance colors
provided by such solid-state sources include orange, yellow, amber, red, and reddish-orange,
5 desirably without need of ancillary spectral filters. The preferred solid-state light-emitting
diodes, at 25° C or thereabouts, operate at a forward voltage of about 2 volts to about 5
volts; have a luminous intensity (measured at the peak of the spacial radiation pattern which
may not be aligned with the mechanical axis of the source package) of a minimum, at 20 mA
current, of about 500 to about 5000 mcd (typical, about 700 to about 7000 mcd); operate at a
10 forward current of about 20 mA to about 50 mA; emit with a dominant wavelength (CIE
Chromaticity Diagram) of about 530 nm to about 680 nm; and have a viewing angle $2\Theta_{1/2}$
(where $\Theta_{1/2}$ is the off-axis angle where the luminous intensity is one half the peak intensity) of
about 5° to about 25°.

A lens assembly 154, which may be a polycarbonate or acrylic material, is
15 positioned over signal light assembly 138. Lens assembly 154 may include a clear or
sinusoidal optical surface 156 and a plurality of louvers 158. Louvers 158 and light-emitting
diodes 152 are skewed away from the passenger compartment of the vehicle. In the
illustrated embodiment, the light-emitting diodes and louvers are skewed at an angle of at
least approximately 15°, more preferably approximately 20°, and most preferably
20 approximately 25° to 30° from the longitudinal centerline of the vehicle, but preferably not
more than about 45°. The purpose of the skewing is in order to allow the light radiated by
the signal light assembly to be visible by drivers in vehicles to the side of vehicle 40, but to

1 be shielded from the driver of the vehicle 40. This features prevents distraction to the driver
of the vehicle equipped with the security lighting system. A cover member 160 encloses
signal light assembly 138 and sinusoidal optical surface 156 by moisture-tight engagement
with flange 146 of enclosure 116. In the illustrated embodiment, light-emitting diodes 152
5 are individually mounted at an angle on circuit board 150. In an alternative embodiment,
light-emitting diodes 152 could be mounted upright, normal to circuit board 150, with the
entire signal light assembly mounted at an angle with respect to the vehicle passenger
compartment in order to provide proper skewing away from the driver of the vehicle
equipped with the mirror assembly security system according to the invention. Also, when
10 desired, a current limiting resistor can be mounted on circuit board 150 in series with the
light-emitting diodes 152 to limit current therethrough and to mate to the 12-volt
ignition/battery potential servicing the exterior mirror assembly.

Enclosure 116 is made from a heat-resistant material and is substantially
moisture impervious. Preferably, a polymer material is used which has a heat distortion
15 temperature (as measured by ASTM D 648 for a 12.7 x 12.7 x 6.4 mm specimen and at
1820 kPa) of at least approximately 80° C, more preferably at least approximately 100° C,
and most preferably at least approximately 120° C. A mineral-filled or glass-filled nylon or
polyester or acrylonitrile butadiene styrene (ABS) polymer may be utilized for enclosure 116.
In the illustrated embodiment, enclosure 116 is made from polycarbonate with cover
20 members 130 and 160 made from a polycarbonate or acrylic. The components of enclosure
116 may be assembled by conventional sonic welding, vibration welding, or by the use of
suitable adhesives. Enclosure 116 is opaque, except for cover members 130 and 160, in

1 order to shade light. The light module fits within the cavity defined within housing 34' by
openings 108 and 110 in a manner which conforms to the styling and aerodynamic lines of
the housing.

5 In an alternative embodiment illustrated in Fig. 25, a light module 104' is
provided that includes a first downwardly directed light-transmitting opening 122 but does
not include a rearwardly directed light-transmitting opening in the housing bezel. Light
module 104' provides a puddle of light around the vehicle's doors, but does not include a
signal light visible by drivers on the sides of the vehicle 40 equipped with light module 104'.
In this manner, a mirror assembly security system, according to the invention, may be
10 provided with a generally downwardly directed security light alone (104') or in combination
with a signal light (104), which may illuminate in unison with the vehicle's turn signal, or
brake lights, or both. Alternatively, signal light 104 may be provided as a stand-alone
module packaged such as described herein and achieving the advantages in terms of
modularity, ease of service/installation, weather resilience, etc., described herein. Thus, it is
15 seen that the present invention provides an exceptionally flexible design which is easily
adapted to various configurations desired by the vehicle manufacturers. Additionally,
because the security system is provided in a unitary module having a unitary cover
member/lens, the invention may be readily adapted to many vehicle housing designs without
requiring extensive re-engineering of the vehicle exterior mirror housing.

20 In another embodiment, a light module 104'' includes side-by-side cavities
134' and 140' (Figs. 26-28). Cavity 134' terminates in a light-transmitting opening 122',
which extends both downwardly and rearwardly with respect to the vehicle. A light-directing

1 lens, or prism, 162 in cavity 134' captures a portion of the light radiated by light source 126'
and directs it rearwardly of the vehicle. The puddle of light produced by light module 104''
is capable of extending rearwardly of the vehicle because of the nature of light-transmitting
opening 122' and the light redirecting effect of prism 162. The second cavity 140' in
5 enclosure 116' includes a light-transmitting opening 136' which extends generally rearwardly
of the vehicle. A light source 138' is positioned within cavity 140' and is surrounded by a
reflector 164, which directs light through light-transmitting opening 136'. A diffuser
assembly 154' includes an integral cover member and louvers in order to direct light radiated
by light source 138' away from the passenger compartment of the vehicle equipped with light
10 module 104''. A unitary cover 130' extends over both openings 122' and 136'. Enclosure
116' includes a surface 166, which is configured with a groove 168, which mates with a
tongue (not shown) in housing 34'' of mirror assembly 36''. The mating tongue-and-groove
surface configuration is repeated on the surface of enclosure 116', which is opposite surface
166. The tongue-and-groove configuration at least partially retains light module 104'' within
15 housing 34'' with a fastener, such as a threaded fastener 169, between an opening in housing
34'' and extending into enclosure 116'. In the illustrated embodiment, light radiated from
light source 126' through light-transmitting opening 122' provides a puddle of light adjacent
the vehicle doors in order to produce a lighted security zone. The light radiated through
light-transmitting opening 136 produced by light source 138' provides a signal indicator,
20 which may be a turn signal indicator, or a brake signal indicator, or both a turn signal and
brake signal indicator.

1 In another embodiment, a light module 104''' includes a removable
fastenerless attachment system 170 including a first member 172 mounted to bracket 43'' and
a second member 174 mounted to enclosure 116' (Figs. 29-31). First member 172 is a clip
connector having a pair of guide members 176a, 176b and a retaining prong 178 overlaying
5 the guide members. Second member 174 includes a wall 180 defining a doghouse type
receiving connector. Guide members 176a, 176b assist the sliding entry of first member 172
into the cavity defined within wall 180 so that prong 178 engages the wall to retain the clip
within the cavity.

With fastenerless attachment system 170, module 104''' is easily and readily
10 mounted by a simple insertion into the receiving opening in the mirror housing such that the
first member is received by and engaged with the doghouse style receiving connector of the
second member. To remove module 104''' for service, a tool, such as a flathead
screwdriver, is inserted in the gap between the mirror element and the lamp module and
prong 178 is raised, using a lift and twist motion, while the module is being pulled outwards
15 from the mirror housing.

In a preferred embodiment, the lamp module of this invention incorporates a
signal light that is a 12-watt #912 incandescent light source available from OSRAM/Sylvania,
Hillsboro, New Hampshire (with about 12-candle power when operated at about 12.8 volts)
mounted in a self-gasketing socket available from United Technologies Automotive, Detroit,
20 Michigan under the trade name E25B-13A686-BA and fabricated of an electrical grade
polyvinyl chloride injection molding compound such as to comply with Engineering Standard
ESB-M4D317-A of Ford Motor Company, Dearborn, Michigan, which is hereby

1 incorporated herein by reference or from a thermoplastic rubber self-gasketing socket. The
socket, in turn, is housed in a unitary enclosure, as described herein, fabricated of heat
resistant polycarbonate supplied by General Electric Plastics, Woodstock, Illinois under the
trade name ML4389 and meeting Ford Engineering Specification ESF-M4-D100-A, which is
5 hereby incorporated herein by reference. The lens is made of acrylic supplied by General
Electric Plastics under the 141-701 trade name. The LEDs in the signal light, of which six
are used, are HLMA-DG00 high power AlInGa solid-state light-emitting diodes supplied by
Hewlett Packard Corporation with a dominant wavelength at 622 nanometers, a peak
wavelength at 630 nanometers, a 30° viewing angle, and a typical luminous efficiency, at
10 25° C, of 197 lumens/watt. When incorporated into an exterior mirror housing and mounted
on a typical automobile, the ground illumination lamp height is approximately 30 ± 5 " from
the ground surface, and, when operated at about 12 volts, the lamp light source illuminates
an approximately 2-foot by 4-foot or thereabouts ground area adjacent the vehicle with a light
level of at least about 10 lux and an average light level of approximately 40 lux.

15 Light modules of this invention, including a ground illumination lamp and a
signal light incorporated into an exterior mirror assembly, were mounted and driven on
vehicles through a variety of driving conditions and through varied environmental exposure,
and were found to have the performance and environmental resilience required by
automakers so as to be suitable for commercial use on vehicles.

20 Although illustrated herein as being located along the bottom rim of the
exterior trim housing, other locations are possible for the signal light of the invention,

1 including the top and outboard rim of the exterior rim housing, and even elsewhere on the exterior vehicle body as appropriate.

Should it be desired to vary the intensity of the signal lights so they are brightest during high ambient lighting conditions, such as on a sunny day, but so that they
5 are dimmer when ambient conditions are lower, such as at night, the intensity of signal light can be modulated using a photosensor such as a photoresistor, photodiode, phototransistor, or their like. A photosensor that controls the intensity of the signal light so that it reduces its intensity during low ambient light driving conditions, such as by pulse width modulation on the electrical line powering the LEDs in the signal light, may be mounted integrally with the
10 lamp module itself, or it may be part of the vehicle electronics itself, such as a photosensor mounted as a part of an automatic electrochromic mirror circuit, as part of a vehicle automatic headlamp activation circuit, as part of a headlamp daylight running light control circuit, or their like.

Also, the concepts of this invention are applicable to a variety of exterior
15 vehicular mirror assembly constructions, including one-part designs, uni-body constructions, and their like, as known in the exterior mirror assembly art. The concepts of the invention are applicable to a variety of assemblies including assemblies that use a bracket as a distinct internal structure and assemblies that do not use a bracket but rather are bracket-less assemblies where the housing itself serves as a structural element with means such as on the
20 walls of the housing for securing an actuator and for receiving a lamp module.

Also, although desirably and preferably finding utility as a security light, the exterior mirror assembly light modules of this invention are also useful for other purposes

1 such as providing for a courtesy exterior light and a general ground illumination light when
✓ such lighting may be desired such as when a door is opening, a key is inserted, or a
keyboard entry is touched, or when approach of a person to a vehicle is detected such as by
voice activation, proximity detection and their like. Also, light modules using the principles
5 and concepts described herein could be provided for mounting on the vehicle other than
within an exterior mirror assembly, such as under a door within a door well or under a door
body panel so as to provide ground illumination directly under a door whenever said door is
opened.

Changes and modifications in the specifically described embodiments can be
10 carried out without departing from the principles of the invention, which is intended to be
limited only by the scope of the appended claims, as interpreted according to the principles
of patent law including the doctrine of equivalents.